

REMARKS

Claims 43-64 are pending in the present application and have been rejected to by the Examiner. Applicants respectfully traverse each ground of rejection and request reconsideration and further examination of the application under 37 CFR § 1.111.

A. Claims 43-44 and 46-47, 49-50, 51-54 and 57-58 were rejected under 35 USC 103(a) as being unpatentable over Buck et al. in view of Xi et al.

The Examiner's combination of Buck et al. and Xi et al. is believed to be improper. Applicant's Claim 43 specifically requires that "several measurement beams with offset spatial, partially overlapping measurement areas covering the orifice completely and at least one of one reference beam and of several reference beams with offset spatial measurement areas are evaluated for determination of at least one of the opening surface area, the volumetric flow rate, the flow volume, and any value proportional thereto."

The Office Action concedes that Buck does not disclose that at least one of the opening surface area, the volumetric flow rate, the flow volume, and any proportion thereto can be determined by evaluating several offset overlapping measurement beams with offset spatial, partially overlapping measurement areas covering the orifice completely and at least one of one reference beam and of several reference beams with offset spatial measurement areas. The Office Action attempts to cure this deficiency in Buck by alleging that Xi shows multiple ultrasound beams produced by a subset of transducer elements in a transducer array wherein the beams overlap and it would have been obvious to use the multiple beam configuration of Xi in the system of Buck.

However, Xi only shows the use of multiple broad ultrasound beams in forming a two dimensional image frame. Prior systems had employed "line scanning," which requires the use of a large number of tightly focused beams to achieve the required image resolution, since the system can only sense reflections in one dimension for each beam. Xi improves upon these systems by using broad beam technology, which allows a transducer group to sense reflections in two dimensions with each beam reflection, thereby covering the same image frame area with a smaller number of beam transmit/receive cycles and without sacrificing resolution. The beams do overlap, however, this overlap is used to cross correlate data from the different beams used to image a given frame and compensate if the material under investigation moves in relation to the sensing transducers between beam generations (column 7, lines 17-25).

It would not have been obvious to use the multiple overlapping beams of Xi in the system of Buck. Xi basically uses sub-images, taken at different times, to create an estimated composite still image frame of an area larger than the individual sub-images (column 8, lines 35-40). At least within each resulting frame, the cross-correlation of beam overlap areas is used by Xi to *compensate* if the material moves during the multiple transmit/receive cycles required to generate a complete frame image. In other words, if there is movement of the material within a frame, the method of Xi attempts to render an image as if the material had not actually moved, thereby reducing the effect of the relative movement on the quality of the resulting image (column 7, lines 25-28).

Buck, by contrast, does not deal with the successive still frame imaging concepts used by Xi. Rather, Buck actually *seeks* to capture the Doppler flow velocity and backscatter acoustic power signals generated by movement of the material under investigation. These signals from moving scatterers, such as red blood cells, are fundamentally different from the reflected

ultrasound signals used by Xi for imaging. Furthermore, the beam overlap described in Claim 43 is mostly a consequence of the fact that the measurement beams are generally not rectangular in nature and tend to degrade in intensity toward their edges, making some overlap necessary in order to encompass the entire orifice area in the flow measurement. This is different from the intentional beam overlap in Xi which is used to verify that the material has not moved between beam generations.

In fact, the only similarity between the two methods is that they both make use of signals in the ultrasonic range. That is, the two methods are resident in two fundamentally different domains of the ultrasound technique. The Xi method works within the imaging domain, using simple reflection to detect tissue borders and create a cross-sectional image of the heart. The Buck method, on the other hand, works within the Doppler domain, and instead uses the spectral Doppler principle to measure the flow of moving blood cells. This spectral Doppler principle is primarily based on the analysis of frequency shift and phase shift of Doppler pulses reflected from moving scatterers and is too complex to be simultaneously combined with imaging modalities.

Therefore, a person of ordinary skill in the art of ultrasound Doppler flow analysis would not have been motivated to look to the teaching of Xi when trying to find a way to measure the Doppler flow velocity and power signals from an orifice which is larger than the beam measurement area because Xi uses the multiple ultrasound scans to build an image that appears to not be moving. Because movement of the subject is precisely what Buck and the current invention desire to measure, one skilled in the art would simply not look to Xi for a solution to the problem. Xi is antithetical to the problem being solved.

Even if the teachings of Buck and Xi were combined, the resulting combination would not provide a desired result. For example, if the overlap areas of the measurement beams were cross correlated using the method of Xi, the system would attempt to *compensate* for the flow of the material, instead of *capturing* the signals generated by the moving material. This would actually hinder the flow measurement and is further evidence that one skilled in the art of ultrasound Doppler flow analysis would not have been motivated to combine the teaching of Xi with Buck. Therefore, it is respectfully submitted that Applicant's Claim 43 is allowable in view of the references of record.

B. Claims 45 and 48 were rejected under 35 USC 103(a) as being unpatentable over Buck et al. in view of Xi et al. and further in view of Nohara et al.

Claims 45 and 48 depend from claim 43 and therefore include all of the limitations of claim 43. It is therefore respectfully submitted that claims 45 and 48 are allowable over the references of record for at least the same reasons set forth above with respect to claim 43.

C. Claims 55-56 and 61 were rejected under 35 USC 103(a) as being unpatentable over Buck et al. in view of Xi et al. and further in view of Nakajima.

Claims 55-56 depend from claim 43 and therefore include all of the limitations of claim 43. It is therefore respectfully submitted that claims 55-56 are allowable over the references of record for at least the same reasons set forth above with respect to claim 43.

D. Claims 59-60 and 62-64 were rejected under 35 USC 103(a) as being unpatentable over Buck et al. in view of Xi et al. and further in view of Buck '181.

Claims 59-60 and 62-64 depend from claim 43 and therefore include all of the limitations of claim 43. It is therefore respectfully submitted that claims 59-60 and 62-64 are allowable over the references of record for at least the same reasons set forth above with respect to claim 43.

For the foregoing reasons, Applicant respectfully submits that the present application is in condition for allowance, and respectfully requests such action. Should it facilitate allowance of the application, the Examiner is invited to telephone the undersigned attorney.

The Commissioner is authorized to charge a three month extension of time fee in the amount of \$510.00 to the credit card electronically detailed in this submission. No additional fees are believed to be necessary, however, should any fees be deemed required, the Commissioner is authorized to charge such fees to Deposit Account No. 23-3030, but is not to include payment of issue fees.

Respectfully submitted,

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